processing radio signals from the second antenna in a second radio frequency processing circuit;

receiving and combining processed radio frequency signals from said first radio frequency processing circuit and from said second radio frequency processing circuit for diversity in a base band processing circuit;

C/ cncld

determining whether diversity is appropriate; and

providing a control signal to said second radio frequency processing circuit to selectively activate and deactivate said second radio frequency processing circuit based on said determination as to whether diversity is appropriate.

REMARKS

Applicants respectfully request reconsideration for the above-captioned application. By the above, a minor change has been made to Claim 13.

Applicants note with appreciation the indication that Claims 3-5 and 14-16 are allowed. Applicants respectfully submit that Claims 1, 2, 6-13 and 17-19 are also in allowable form.

The Office Action includes a single rejection of Claims 3-5, 6-13 and 17-20[1] under 35 U.S.C. § 103 as allegedly being obvious over the prior art illustrated in Figure 3 of the present application in view of the Conner et al. patent (U.S. Patent No. 6,256,484). This is rejection is respectfully traversed.

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[1] It is assumed that the Examiner meant to include Claim 20 in the rejection in light of the Office Action summary sheet

The present invention involves a method for a controlling antenna diversity. Antenna diversity is advantageous to counteract the common problem of cellular radio communication systems of the loss of information in the uplink and downlink signals resulting from multipath fading. Multipath fading occurs when a transmitted signal travels along several paths between a transmitting station and its intended receiver.

Fading can be mitigated by using multiple receiver antennas using some form of diversity combining, such as selective combining, equal gain combining or maximal-ratio combining. Diversity takes advantage of the fact that fading on different antennas is not the same, so that one antenna has a faded signal, chances are the other antenna does not. Hence, having multiple antennas, and processing the information accordingly, helps combat fading and makes the communication link more robust. However, the price of introducing antenna diversity with the extra radio and base band processing, this additional processing requiring additional space, manufacturing costs and power consumption.

It has been observed that antenna diversity may not be needed in some situations, such as in radio environments which allow perfectly adequate performance without diversity. Hence, antenna diversity can end up spending power on the diversity processing whether necessary or not. This results in shorter operating time for the battery.

In light of these factors, the present invention mitigates the power penalty of introducing diversity in a mobile station by using the diversity branch only when needed. Stated differently, the diversity branch can be controlled (e.g., switched on or off) by the base band processing circuitry where it is decided that the performance gain from using diversity outweighs the extra power consumption in certain circumstances.

As disclosed at page 4 in the present application, systems such as the IMT 2000 are defined in a way where diversity is more or less necessary to meet some of the specific performance requirements. The overall criteria is to meet some kind of performance measure for the communication link. This can be monitored in any one of several ways such as the signal-to-noise ratio of the received signal, estimated or measured bit error rate, or frame error rate, or by keeping track of the number of required re-transmissions where the radio link protocol uses re-transmissions. In most cases, both antenna signals need to be fully processed and the process signals combined in the most beneficial manner.

Figure 3 of the present application is an example of such a system. In Figure 3, a first antenna 310 receives radio signals and provides its received signals to a first RF processor 330. A second antenna 312 receives radio signals and provides its received signals to a second RF processor 332. The first RF processor 330 processes, e.g., down converts, the received RF signal to an intermediate signal for input to a base band processor 340. The first RF processor 330 also processes signals to be transmitted, including converting the signal to a radio frequency for transmission over the first antenna 330.

Simultaneous with the processing of the first RF signal in the first RF processor 330, the second antenna 312 receives the same signal from the same source, but perhaps over a different radio path. This second signal is processed (e.g., down converted) in the second RF processor 332. The second signal is processed in the second signal processor 332 before being forwarded to the base band processor 340. The second RF processor 332 operates only in a receive mode.

The need for a lot of extra processing when using diversity is particularly true for systems based on CDMA, since in this case the antenna signal has to pass through most of the base band processing before the quality thereof can be judged. Simple measurements like signal strength do not give enough information about one individual user signal.

Although antenna diversity may be needed in some situations, there will be other cases where the radio environment allows perfectly adequate performance without diversity. If diversity is implemented such as shown in Figure 3, the mobile station ends up spending power on the diversity processing whether necessary or not. This leads to shorter operating time for battery operated devices that could have been achieved without the power consumption in the diversity chain.

The present inventors have reduced the power penalty of introducing diversity in the mobile station by using the diversity branch only when needed. Figure 4 depicts a solution where the diversity branch can be controlled (i.e., switched on or off) by the base band processing circuitry. In this way, it can be decided when the performance gain from using diversity outweighs the extra power consumption and then switch to the diversity processing only in the latter situation.

The Conner et al. Patent

The Office Action characterizes the Conner et al. patent for disclosing selectively deactivating "a second radio frequency processing circuit 18a based on a determination as to whether diversity is appropriate (see column 1, line (sic) 50-59)." Applicants respectfully contest this characterization of the Conner et al. patent.

The Conner et al. patent discloses a system wherein signals from a first antenna 18 and a second antenna 20 are combined at a point 22 when a switch is closed. The first and second antenna are disconnected from each other when the switch is open. What is important to note is that the signals are combined before being received in a RF FM receiver 13. In other words, the Conner et al. patent represents a system more akin to Figure 2 of the present application rather than the present invention or the diversity processing shown in Figure 3.

The stated motivation for the hypothetical modification of Figure 3 to include a switch such as disclosed in the Conner et al. patent it is "in order to obtain an inexpensive and simple diversity receiver (as suggested by Conner at column 2 lines 43-49)." However, the modification suggested in the Office Action is completely contrary to this motivation. The Conner et al. disclosure might suggest modifying the selective diversity of Figure 2 to include a switch between antennas 210 and 212 so that occasionally both antennas are used and a combined signal then processed in the RF processing circuit 230. This would not, however, result in the present invention. To modify Figure 3 to include a switch affecting the second RF processing circuit 332 would lead to a more expensive and complicated diversity receiver, rather than following the teachings identified by the Office of the Conner et al. patent. Accordingly, there is no motivation in the applied art, and in fact the Conner et al. patent teaches away from modifications which would result in the present invention.

For these reasons, Applicants respectfully request that rejection be withdrawn and all the claims passed to issuance.

Having noted marked distinctions between the applied art and the independent Claims 1 and 13 and a lack of motivation to modify the prior art to result in the present invention, Applicants respectfully submit that all of Claims 1, 2, 6-13 and 17-20 are in allowable form. Accordingly, Applicants will not dwell on the additional distinctions found in the depending claims. Applicants respectfully request issuance of a Notice of Allowance. Should any residual issues arise, the Examiner is invited to contact the undersigned at the number listed below.

Respectfully submitted,

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Attachment to Amendment

Marked-up Claim 13

13. (Amended) A method of controlling diversity in a mobile station, comprising:

receiving a radio signal on a first antenna;

processing radio signals from said first antenna in a first radio frequency processing circuit;

receiving radio signals in a second antenna;

processing radio signals from the [first] second antenna in a second radio frequency processing circuit;

receiving and combining processed radio frequency signals from said first radio frequency processing circuit and from said second radio frequency processing circuit for diversity in a base band processing circuit;

determining whether diversity is appropriate; and

providing a control signal to said second radio frequency processing circuit to selectively activate and deactivate said second radio frequency processing circuit based on said determination as to whether diversity is appropriate.